NAVAL WAR COLLEGE

Newport, RI

COLLABORATIVE EXPLOITATION AND ANALYSIS: HELPING THE JOINT FORCE COMMANDER ACHIEVE INFORMATION SUPERIORITY

by

Mr. James Kren, NIMA

A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

Signature: James Kren

13 February 1998

Professor Elizabeth A. McIntyre, CIA Representative
Joint Military Operations Department

REPORT DOCUMENTATION PAGE

1. Report Security Classification: UNCLASSIFIED	
2. Security Classification Authority:	
3. Declassification/Downgrading Schedule:	
4. Distribution/Availability of Report: DISTRIBUTION STATEMENT A: APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.	
5. Name of Performing Organization: JOINT MILITARY OPERATIONS DEPARTMENT	
6. Office Symbol: C	**7. Address:** NAVAL WAR COLLEGE 686 CUSHING ROAD NEWPORT, RI 02841-1207
8. Title (Include Security Classification): Collaborative Exploitation and Analysis: Helping the Joint Force Commander Achieve Information Superiority (UNCLASSIFIED)	
9. Personal Authors: James Kren, NIMA	
10.Type of Report: FINAL	**11. Date of Report:** 13 February 1998
12.Page Count: 27	
13.Supplementary Notation: A paper submitted to the Faculty of the NWC in partial satisfaction of the requirements of the JMO Department. The contents of this paper reflect my own personal views and are not necessarily endorsed by the NWC or the Department of the Navy.	
14. Ten key words that relate to your paper: NIMA, Collaborative, Exploitation, Analysis, JFC, information, superiority, requirements, geospatial, imagery,	

15.Abstract: The National Imagery and Mapping Agency's (NIMA) new concept of Collaborative Exploitation and Analysis provides a "virtual staff" that can augment the Joint Force Commander (JFC) during mission analysis, planning, and execution. By 2010, Collaborative Exploitation and Analysis will help the JFC achieve information superiority -- provided the JFC understands what it can do for him and therefore knows to ask for this help. Current and emerging technology provides the capability to share all types of information in real-time. Recent advancements in collaborative computing have achieved document sharing between physically remote sites, object-oriented database sharing, as well as shared applications. Collaborative Exploitation and Analysis is the advancement of these technological capabilities to achieve a network of imagery and geospatial databases, and dynamic workgroups to resolve time critical issues. Information superiority is significant to the JFC because constant knowledge about the battlespace improves mission effectiveness. Information superiority supports operational art concepts. Requirements for achieving information superiority are battlespace awareness, effective employment of forces, and a communications grid (network) that ensures uninterrupted/uncorrupted service. Since October 1996, NIMA has been striving to move the imagery and geospatial communities closer together through its leadership of the United States Imagery and Geospatial Information System (USIGS). In this role, the agency is developing an end-to-end architecture to provide an environment that ensures the information edge. Collaborative Exploitation and Analysis is integral to evolving the current, static environment to one that allows the JFC access to imagery, geospatial information, and analytical expertise.

16.Distribution / Availability of Abstract:	**Unclassified** X	**Same As Rpt**	**DTIC Users**
17.Abstract Security Classification: UNCLASSIFIED			
18.Name of Responsible Individual: CHAIRMAN, JOINT MILITARY OPERATIONS DEPARTMENT			
19.Telephone: 841-6461		**20.Office Symbol:** C	

ABSTRACT

The National Imagery and Mapping Agency's (NIMA) new concept of Collaborative Exploitation and Analysis provides a "virtual staff" that can augment the Joint Force Commander (JFC) during mission analysis, planning, and execution. By 2010, Collaborative Exploitation and Analysis will help the JFC achieve information superiority -- provided the JFC understands what it can do for him and therefore knows to ask for this help.

Current and emerging technology provides the capability to share all types of information in real-time. Recent advancements in collaborative computing have achieved document sharing between physically remote sites, object-oriented database sharing, as well as shared applications. Collaborative Exploitation and Analysis is the advancement of these technological capabilities to achieve a network of imagery and geospatial databases, and dynamic workgroups to resolve time critical issues.

Information superiority is significant to the JFC because constant knowledge about the battlespace improves mission effectiveness. Information superiority supports operational art concepts. Requirements for achieving information superiority are battlespace awareness, effective employment of forces, and a communications grid (network) that ensures uninterrupted/uncorrupted service.

Since October 1996, NIMA has been striving to move the imagery and geospatial communities closer together through its leadership of the United States Imagery and Geospatial Information System (USIGS). In this role, the agency is developing an end-to-end architecture to provide an environment that ensures the information edge. Collaborative Exploitation and Analysis is integral to evolving the current, static environment to one that allows the JFC access to imagery, geospatial information, and analytical expertise.

Imagine yourself in the year 2003. In terms of imagery and detailed location data support to the Joint Force Commander (JFC), the world has changed drastically. In order to take advantage of it, you, the JFC, must understand what resources are out there and how they can help you. <u>This</u> is a snapshot of what you might expect...

United States Imagery and Geospatial Information System (USIGS) Support to the JFC in the near future[1]

The Story below shows how the several USIGS initiatives come together to allow the responsive, accurate imagery and geospatial information support which users will require in 2003. As the information cycle proceeds -- from the establishment of a requirement to a user's having the answer to his question, the initiatives work together, and without the capabilities embodied in each, the others will not function as designed or required. [The National Imagery and Mapping Agency (NIMA) is the functional manager for USIGS].

The Situation A joint task force (JTF) has been formed in early July, 2003, as the US component of a multinational operation to quell a rebellion in a third-world nation. US citizens and citizens of the other nations participating in the operation are being held hostage in several areas of the capital city. The multinational force has been given the mission of rescuing the hostages and restoring the elected government to power. The commander of the US joint task force has entered the area of operations with a robust C4I structure, including **a deployable NIMA Imagery Library as part of the NIMA Library Initiative,**[2] populated with baseline imagery and geospatial information on the area of operations. US amphibious forces, supported by US and coalition special operations forces and tactical air assets, are scheduled to make an opposed landing as part of the rescue force tomorrow at first light. Intelligence Preparation of the Battle Space is virtually complete. The theater commander's intelligence plan for federated intelligence support was activated in the planning phases of the operation. The NMJIC [National Military Joint Intelligence Center] has organized the JICs and JACs [Joint Intelligence Centers/Joint Analysis Centers] of supporting commands, NIMA, and DIA in a **federated intelligence support** structure.[3] NIMA has provided the **necessary policy framework to permit essential sharing of imagery-derived information**[4] with coalition partners.

A Critical Operational Question Is Asked On the eve of the rescue operation, the US joint task force commander received a tip-off from SIGINT [signals intelligence] that a group of US hostages would be moved from the US embassy to a newly constructed office building two miles away. The JTF commander needs the latest imagery of the building to which the hostages are being moved, including floor plans and the areas in which his troops would be most vulnerable to insurgent attack during the rescue operation. He is also concerned about potential insurgent opposition to the rescue operation, and has levied a requirement for information on military movements and changes in the defenses in the vicinity of the building and its approaches. The deployable NIMA library on his flagship has complete imagery and digital geospatial information on the area of the capital city in which the building sits, but it has no imagery of the building after completion, nor is there historical coverage which would give the building's interior layout. His J2 passes the information requirement to the theater JIC, with a request that the information be provided before 0400 local time, to allow the landing force time to factor it into their planning. Upon receipt of the JTF commander's requirement, the JIC determines that some new collection will be required to satisfy the requirement, and that the imagery part of the answer can be provided by a combination of UAV's [Unmanned Aerial Vehicle] and national systems. The collection manager at the JIC enters the requirement in **RMS [Requirements Management System], including the requirements for exploitation and distribution.**[5]

New Imagery Is Collected, Existing Information is Pulled Together At the theater Joint Reconnaissance Center, the requirement for advisory tasking of theater UAVs against the building where the hostages will soon be is received. The JRC accepts the tasking and arranges for UAV coverage of the area two hours before first light. UAV video will be sent from the UAV to a **Common Imagery Ground Station** and then fed to the JIC for injection into the **Joint Broadcast System (JBS)** video channel. NIMA's Central Imagery Tasking Office receives the collection requirement for national imagery and determines that [current national coverage does not exist]. . . At the JIC, imagery analysts, working with their all-source counterparts, have determined that . . . the building was obtained as "bonus" coverage [by the UAV] a day earlier. Coverage is obtained by a national system as tasked. . . and the coverage is received at the JIC and supporting JICs . . . before 0100. Simultaneously, the imagery enters the **National Imagery Library.**

The Pieces of the Puzzle Are Put Together - Analysis and Production By the time the national system coverage arrives at the theater JIC, analysts at **softcopy workstations**[6] have already begun their work. The capabilities of the **Exploitation Support System** have allowed the analysts to begin work with baseline data already pre-staged at their workstations. The JIC's imagery analyst cadre has reaped the benefit of the **Imagery Analyst Initiative,**[7] and the command not only has increased its IA numbers, but has also seen the experience level rise with the cross-fertilization of IA's with NIMA and the career development which the initiative allowed. . . The exploitation tools provided by the **Exploitation Tools Initiative**[8] will also allow the IA's to do the in-depth analysis the commander requires. One IA has already begun to provide an Image Perspective Transformation (IPT) view of the building, using imagery and geospatial data provided as a result of the **GIIPT Initiative**[9] to provide a ground-level view of the approaches to the building from the harbor area. When the exploitation and analysis tasks were apportioned as a **collaborative exploitation** effort, NIMA IA's were assigned the task of providing in-depth analysis of the building. Using imagery of the building in various stages of construction available in the National Imagery Library, NIMA's had the information available before 0200 (theater time) and injected on **JBS** through the **Joint Information Management Center (JIMC)** in the Pentagon. Throughout the analysis process, IA's and all-source analysts at the theater JIC, supporting JICs, NIMA, and DIA worked together, in many cases using whiteboard and video teleconferencing. [10]

The Information Gets to the User - On Time By 0300, all of the pieces of the puzzle had come together. The theater JIC had completed its portion of the analysis. The IPT was on the **Image Product Library (IPL)**[11] server and had been sent to the theater information management center for injection on the GBS broadcast to the JTF commander afloat. NIMA's in-depth analysis of the building was also in the hands of both the JTF commander and the theater JIC. In the meantime, the UAV had arrived on station at 0245, well in advance of first light. At 0330, the JTF commander received a HUMINT report through his National Intelligence Support Team (NIST) that the insurgents were moving the US hostages to the new office building, just as SIGINT had predicted. As the landing force completed its preparations, man-portable IPLs provided under the **NIMA Library Initiative** were being loaded with the information just received on the building and its approaches. At 0430, the assault force helos lifted off the LHD on their way to the port area. At 0515, as dawn was breaking, the force entered the office building, overwhelmed the still groggy guards, and evacuated the hostages even as the main body of the multinational force began their assault on the capital.

The preceding scenario illustrates the importance of information superiority to the future Joint Force Commander (JFC). The system described has the potential to provide a constant flow of imagery, imagery intelligence, and geospatial information to the JFC. Without the updated information, the notional rescue operation would not have been successfull. The National Imagery and Mapping Agency's (NIMA) new concept of Collaborative Exploitation and Analysis is incorporated into the above scenario. This concept provides a "virtual staff" that can augment the JFC during mission analysis, planning, and execution. By 2010, Collaborative Exploitation and Analysis will help the JFC achieve information superiority -- provided the JFC understands what it can do for him and therefore knows to ask for this help.

In order for future JFCs to understand how "Collaborative Exploitation and Analysis" can help him attain information superiority, he needs to learn a few basic concepts. One such concept is "collaborative computing." Collaborative computing is the capacity for one or more people (and/or applications) to share information in actual time. Examples of collaborative computing include file transfer, electronic mail, simultaneous sharing (whiteboard), desktop audio and video conferencing, and data conferencing. Technology now provides the capability to share all types of information in real-time. Recent advancements in collaborative computing have achieved document sharing between physically remote sites, object-oriented database sharing, as well as shared applications.[12]

Collaborative Exploitation and Analysis is the advancement of the above capabilities to achieve:

- Worldwide network of imagery/geospatial databases that allows sharing of imagery/geospatial and supporting data across a large community of users (i.e. Defense and Intelligence users)
- Worldwide, dynamically-formed workgroups of analysts, providers and consumers to resolve time-critical issues
- Cooperation among individual imagery/geospatial analysts from different organizations on joint exploitation tasks in real-time
- Direct Access to NIMA's imagery/geospatial expertise
- Near real-time cooperation between analysts and end users for updates.[13]

In this paper we will look at the concept of information superiority, its operational impact and significance, and what it requires. We will also look at NIMA's efforts to ensure future information superiority. The bulk of the paper will focus on Collaborative Exploitation and Analysis, what it is and how it can help the JFC attain information superiority. Finally, we will look at some recommendations on how to refine this concept so that it can more effectively assist the JFC in attaining informational superiority.

I. INFORMATION SUPERIORITY (WHAT IS IT, WHY DOES IT MATTER TO THE JFC, REQUIREMENTS, AND WHAT IS NIMA DOING?)

A. What is Information Superiority

The Joint Chiefs of Staff (JCS) defines information superiority as the "degree of dominance in the information domain that permits the conduct of operations without effective opposition."[14] Joint Vision 2010 defines information superiority as "the capability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary's ability to do the same."[15] The significance of information flow to the

JFC is the focus of this paper; aspects of information operations and protection are not being addressed in this report.

Information superiority depends in large part on information systems. Information systems provide for the "collecting, processing, analyzing, archiving, and disseminating of information."[16] Among the types of information needed for information superiority are audio, imagery, video, geospatial information (digitized mapping), command and control (orders, instructions), as well as order of battle.[17] Collaborative Exploitation and Analysis does not require massive new systems; rather it is the is expanded use of these information systems to allow our side dominance. The required infrastructure to support a collaborative environment, within the defense and intelligence communities, has already begun to emerge. NIMA's concept brings the various types of information together to achieve information superiority. At the same time, Collaborative Exploitation and Analysis guarantees the information provided to the JFC is mission relevant.

B. Why does Information Superiority matter to the JFC?

Information superiority is significant to the JFC because constant knowledge about the battlespace improves mission effectiveness. As described in the rescue operation, constant information updates were made available to the JFC. The JFC required updated imagery, building plans, and information regarding insurgent movements. By receiving timely, relevant information, the JFC and his staff were able apply precision force for the rescue mission. Furthermore, the rescue forces were able to visualize the mission prior to execution.

Information superiority supports operational art concepts. Information superiority (or dominant battlespace knowledge - DBK) can allow the JFC to plan and execute the operation in such a way as to make his adversary ineffective. "DBK lets commanders exploit seams in the enemy's forces, gaps in his abilities, and openings provided by his sequential operations. Forces and fires can be rapidly reassigned between holding, breakthrough, and exploitation operations."[18]

C. Information Superiority Requirements

Recent studies by the Office of Secretary of Defense, defined three requirement areas for achieving information superiority. These include battlespace awareness, effective employment of forces, and a communications grid (network) that ensures uninterrupted/uncorrupted service. [19]

Battlespace awareness is the ability to obtain and understand information concerning the location and activity of friendly, opposing, and disengaged forces, along with the geospatial environment (i.e. terrain, weather, bathymetry, transportation networks) in which these forces are operating.[20] Battlespace awareness is essential during analysis of the factor space while executing the Commander's Estimate of the Situation (CES). Knowledge about a theater's physical characteristics and how they impact combat operations is essential in completing the CES mission analysis.[21]

Information superiority would enable the JFC to understand fully the battlespace and then to develop an **effective scheme** for engaging in the conflict. For a JFC to come up with an effective scheme, he needs the output of a wide range of tactical, operational, and national

intelligence, surveillance, and reconnaissance assets. The information derived from these assets facilitates mission analysis, planning, selection of courses of action, combat assessment (battle damage assessment), synchronization of operations, and rapid target acquisition.[22] An example of how battlespace awareness contributes to an operational plan is the selection of decisive points. Complete battlespace awareness by the JFC enables the recognition of appropriate decisive points. In the hypothetical rescue operation, the JFC requested specific information regarding potential decisive points. Considering the information provided (through the collaborative process), the JFC can select egress routes to avoid vulnerable areas. Information superiority would also provide the rapid ability to recognize physical objectives for friendly forces. The accurate analysis of enemy courses of action is also greatly assisted by possessing information superiority.

Information superiority requires a world-wide, flexible, assured network that supports operations across the board. Specific requirements for using a **global "grid"** include time-critical functions such as "sensor-to-shooter" information flows. Additionally, the establishment of "virtual staffs" that will compliment and enhance the JFC's deployed resources has been identified as a requirement for future communications capabilities. These "virtual staffs" can reduce the size of a joint task force on the ground, provide collaborative services, and enable access to additional resources the JFC would not normally be able to reach or task. Among the specific functional capabilities for information superiority are: intelligent, distributed mapping, charting, and geodesy (or geospatial), collaborative situation assessment and battle damage assessment, and shared, distributed collaborative planning.[23]

NIMA's strategy for implementing Collaborative Exploitation and Analysis directly supports these required capabilities for information superiority.

D. NIMA's response to Information Superiority

The NIMA was established as a Department of Defense (DOD) agency on 1 October 1996. Congress established NIMA as a combat support agency as well as an intelligence agency. NIMA's mission is to provide imagery, imagery intelligence, and geospatial information and services to its customers. In addition to acquiring, producing, and delivering information, the agency coordinates imagery collection, processing, exploitation, and dissemination requirements among the DoD, Intelligence Community, National Security Council, and other federal government agencies and departments.[24,25] As detailed in Joint Vision 2010, NIMA's establishment was a step toward achieving information superiority.

A major accomplishment for NIMA since being established has been its service as the lead for the DOD wide Geospatial Information Integrated Product Team. This team's direction came from the Defense Science Board, as well as from the Assistant Secretary of Defense for Command, Control, Communications and Intelligence. The task of the team was to articulate the requirements and concepts for a Geospatial Information Infrastructure. The team was also charged with successfully demonstrating this infrastructure.[26] This infrastructure consists of "people, doctrine, policies, architectures, standards, and technologies necessary to create, maintain, and utilize geospatial information in the context of a geospatial framework." [27]

The team completed their tasks in October 1997. One of the end products was to test and report on several commercial geospatial production technologies that could support rapid response for very specific geospatial information. These tests results provided technical specifications for acquiring the best commercial tools for NIMA. This production environment consists of commercial technology that can be "clustered" together with imagery analysts and cartographers to create mission-specific data for both the warfighter and the national/strategic decisionmaker.[28] NIMA's efforts since the agency's creation have sharply been focused on achieving information superiority.

II. HOW CAN COLLABORATIVE EXPLOITATION AND ANALYSIS HELP THE JOINT FORCE COMMANDER?

A. USIGS and the Collaborative Process

The Geospatial Information Integrated Product Team describes the goal for collaborative computing as the creation of a "virtual production environment" with dispersed production areas exchanging information with end-user organizations.[29] This type of production environment strengthens the combination of multiple distributed sources of data and views into an extensive information product. "Such a collaboration leads Geospatial Information Infrastructure (GII) production assets (intelligence and geospatial) to contribute processed information directly and interactively - and in real time - to the common, integrated and relevant view of the battlespace and, inversely enables NIMA to partner with its users by responding to real time information update requests."[30] The story of the joint

task force at the beginning of this paper, validates that the USIGS collaborative process will contribute to overall information quality and relevance to the mission.

The information NIMA provides to the warfighter (imagery, imagery intelligence, and geospatial information) provides the JFC a backdrop against which to arrange other battlespace information. Bringing all of these different sources together provides the JFC with the possibility of achieving information superiority.[31] Collaborative Exploitation and Analysis allows for the merging of these sources to occur in real-time with the JFC's mission specific needs (intent) driving the production/analysis process.

B. Value Added by Collaborative Exploitation and Analysis

Although Collaborative Exploitation and Analysis will most often provide support through the JFC's staff, the JFC might want to directly request specific information or provide his perspective to the joint analysis process. The value added by Collaborative Exploitation and Analysis is that national agency resources can be provided directly; the JFC can look at these specialized geospatial or intelligence products crafted by NIMA's Integrated Production Cells (or "clusters") to meet mission requirements.

The NIMA's civilian workforce is a national asset used by both the national decisionmaker and the JFC. NIMA cartographers, geographers, imagery analysts, and information specialists can provide "virtual" staff augmentation for the JFC. In the future, commercial technology will allow our adversaries to obtain excellent access to information; the difference between success and failure will be in the analysis of that information.

The NIMA has been incorporated into the deployable National Intelligence Support Team (NIST) structure to support the JFC (particularly at the Joint Task Force level). By coupling the collaborative process together with forward-deployed NIST assets, requests for information could be better prioritized and understood by national level support agencies. The JFC would be able to verbalize requests through the collaborative process instead of pushing requests via multiple messages.

C. Collaborative Exploitation and Analysis--NIMA's Incremental Dividends

The Defense Mapping Agency (DMA), one of the agencies incorporated into NIMA, participated in Joint Warrior Interoperability Demonstration (JWID) 1995 as a partner in the Contingency Collaborative Targeting demonstration. Through the use of collaborative tools such as shared applications (including shared imagery) and audio, DMA experts provided imagery and real-time points measurement for critical targets. The collaborative targeting sessions involved all targeting nodes of a joint task force communicating over the Secret Internet Protocol Router Network. The geographic locations for this demonstration reached from Washington DC to Camp Pendleton, CA. The group collaboratively selected a desired mean point of impact, shared the Rapid Application of Air Power viewing tools, and each participant updated their portion of the targeting database in development of the Air Tasking Order. DMA contributed precise geographic points and analysis for the required targets. The successfull demonstration of this technology during JWID 1995 led the Joint Chiefs of Staff,

Intelligence Directorate, Targeting, to support follow-on development and incorporation into the Global Command and Control System as a leading edge service.[32]

Recently, the collaborative targeting technology supported a Third Fleet exercise (Silent Fury) aboard the U.S.S. Coronado. NIMA was a crucial provider of mensurated point target information by participating in collaborative targeting conferences and posting target information on a web site. NIMA experts produced nearly 600 mensurated points during the exercise, supporting systems such as the Joint Stand-Off Weapon.[33]

DMA's demonstration in JWID 1996 built on the lessons from JWID 1995. At JWID 1996, DMA successfully demonstrated a collaborative geospatial production network. A Geopositioning Satellite System receiver and a wearable computer assisted in the collection of land minefields and coastline data. DMA and J2 (intelligence) personnel created updated geospatial data depicting these features using the collaborative production network. Communicating over the network and using commercial workstations, other components of the joint task force collaborated to further "tailor" information products for their specific needs.[34] Network collaboration involving cartographers, image analysts, and components of the joint task force, provided updated geospatial information to the JFC in hours instead of weeks.[35]

Although NIMA did not develop technologies directed at collaborative production for JWID 1997, collaborative tools supported many demonstrations. NIMA personnel witnessed that collaborative planning has increased and is being incorporated within the joint task

force/coalition task force environment. Additionally, desktop video teleconferencing is being used on a wider scale and is gaining acceptance for conducting mission planning.[36]

D. Other Examples of Collaborative Computing within DOD and the Intelligence Community

The benefits of collaborative computing are being studied for possible application not only by NIMA, but throughout the defense and intelligence communities. A recent study concerning the incorporation of remote elements for a combat air staff suggests the use of a "virtual staff" can reduce the resources necessary to support concepts such as the Air Expeditionary Force. The use of collaborative networking could ensure the required expertise exists in the air combat staff while permitting more personnel to remain at home bases.[37] Many other organizations are beginning to incorporate collaborative technology into their production environment. For example, the MITRE Corporation, a federally-funded research and development center, has been developing a collaborative virtual workspace for their intelligence community customers. The intelligence community is attempting to create a radically new method in generating and disseminating intelligence information.[38] NIMA, along with the Defense Intelligence Agency, has supported the community's efforts by co-sponsoring an annual conference on collaborative computing.[39]

E. Limitations of Collaborative Exploitation and Analysis

It is important to note that Collaborative Exploitation and Analysis cannot provide all the elements of battlespace awareness to the JFC. Other types of information will remain critical in the employment of weapons, determining the enemy's capabilities, intent, and

possible courses of action. Human and signals intelligence remain essential in providing the JFC a complete assessment of the situation. Signals intelligence remains a vital source for gathering information on diplomatic issues, enemy military plans, and technological characteristics of enemy forces.[40] Human intelligence is still relevant in today's technological environment of intelligence collecting. The JFC must place a high priority on human sources to ensure the questions and assumptions left by other types of intelligence collection do not become risks.[41]

A limitation of collaborative technology in general, is that "virtual staffs" operating in a military hierarchy, create organizational challenges to command and control. These challenges include organizing a "virtual staff," maintaining centralized command in a network environment, and guaranteeing "virtual staffs" will maintain their support to forward based elements.[42]

Additionally, in today's coalition environment, it is essential to have observable signs of coalitions being fully integrated during military operations. The use of collaborative technology during a coalition could make it difficult to maintain symbols of cohesion.[43] Although the collaborative process can support some coalition operations, the concept alone will not provide a visible sign of unity.

Current deficiencies in collaborative technology also provide limitations. These deficiencies center on limited interoperability between the different types of tools and various operating systems. Limited interoperability is evident among the available audio and video

conferencing tools. Finally, full conversion and adherence to collaborative tools for imagery and geospatial analysis are still unproved within the community.[44]

F. Technology forecast for collaborative tools and "virtual staffs"

A recent study by RAND states that the predictions for collaborative technology are achievable. The future of collaborative computing relies on the availability of greater processing power and the capacity to examine information in a timeframe that supports high speed decisionmaking.[45]

III. RECOMMENDATIONS

NIMA will have future opportunities to further demonstrate the concept of collaborative production and its application to the JFC. The Defense Technology Area Plan outlines various defense technology objectives and advanced concept technology demonstrations that directly support information superiority. Close coordination with the program managers of these demonstrations will allow NIMA to directly contribute in the advancement of collaborative planning across the defense community. NIMA has previously participated with the Rapid Battlefield Visualization demonstration by producing highly detailed terrain and feature information for a three dimensional view. However, future iterations of this effort will include a collaborative battle planning capability. NIMA could further demonstrate the Geospatial Information Infrastructure by developing the required terrain and feature data through the collaborative process. Another advanced technology demonstration that NIMA should pursue is the Joint Task Force demonstration. This

demonstration highlights tools that support widely separated elements of a joint task force. Included in these tools is the planned capability to provide enhanced collaboration to generate a common perception of the battlespace.[46] NIMA can contribute to this process by demonstrating portions of the Collaborative Exploitation and Analysis process. One other opportunity for NIMA to validate how Collaborative Exploitation and Analysis supports the JFC, is by participating with the DOD Information Superiority Integrated Product Team. This integrated team is relying on NIMA to provide inputs into various information superiority experiments. The mission of the information superiority team is to:

- Integrate Joint Staff, Combatant Commanders in Chiefs (CINCs), Services and Agency Information Superiority initiatives
- Define common objectives
- Establish principles for network centric warfare
- Establish guidelines for conducting information superiority experiments
- Agree on progress assessment methodologies
- Address acquisition issues.[47]

In order for NIMA to assist in the implementation of Joint Vision 2010 and the concept of information superiority, the United States Imagery and Geospatial Information System must establish a legitimate Collaborative Exploitation and Analysis capability. Collaborative tools will provide opportunities for NIMA to fully augment joint task forces for critical time-sensitive analysis and decisionmaking.

Specific recommendations for Collaborative Exploitation and Analysis focus on helping current and future JFCs to understand why this matters to them. Through continued demonstrations and participation in exercises, NIMA will be able to secure "buy in" from the Services, Commands, and other national support agencies.

Specific internal NIMA organizations need to take the lead to ensure Collaborative Exploitation and Analysis gains the required visibility and acceptance. The NIMA Systems and Technology organization should incorporate existing elements of the collaborative concept (e.g., collaborative targeting) into every advanced demonstration, technology experiment, or exercise (e.g. US Strategic Command's Global Guardian Exercise) the agency supports. As the capability further develops, the NIMA Customer Support office should place an emphasis on using this concept for crisis support. These efforts will allow NIMA's Directorate of Operations to integrate the collaborative process as a standard support capability.

Organizations outside of NIMA must anticipate how information superiority will affect future command and control structures. Collaborative technology will force end-user groups to establish new schemes for organizing, collecting, producing, and validating information. Future JFCs must prepare for combining non-traditional organizations into their task forces or supporting elements. Future leaders must recognize that "virtual staffs" can provide enhanced capabilities and information without being intrusive. Collaborative technology allows transparent national agency support.

These specific activities provide a starting point for collecting valid requirements from the defense and intelligence communities. External groups currently developing new methods for information processing will recognize the contribution NIMA's concept can provide to the JFC. With the collection of requirements and full development of NIMA's

collaborative concept, the Integrated Production Cells ("clusters") can expand agency support to the JFC.

In conclusion, Collaborative Exploitation and Analysis will help the JFC achieve information superiority by 2010. Continued development, demonstration, and integration of this process into emerging systems, will ensure "virtual staffs" support future joint operations.

NOTES

[1] National Imagery and Mapping Agency (NIMA), United States Imagery and Geospatial Information System (USIGS) Architectural Framework (UAF), 26 August 1997, 54, Lkd: <http://www.nima.mil/aig/> (2 January 1998).
This verbatim narrative illustrates NIMA's strategic planning as of January 1998. NIMA's vision is to provide easy access to timely/tailored information instead of distributing standard hardcopy products to customers. To date, the majority of the initiatives, in bold type, have been funded and will continue to be fully developed/implemented over the next several years.

[2] The NIMA Library Initiative is an effort to develop a global client-server environment which delivers imagery, imagery intelligence, and geospatial information through the application of user profiles that allow (smart push) or through a request (smart pull) from NIMA libraries by customer organizations. Client platforms include a wide range of existing hardware and future hardware capabilities. See also, NIMA, United States Imagery and Geospatial Information System (USIGS) Operational Architecture: The Operational Concept Diagram (OCD), Draft, 24 June 1997, 15, Lkd: <http://www.nima.mil/aig/> (2 January 1998).

[3] The federated intelligence support structure is a planned capability that will mobilize required expertise from national support organizations to support the combatant commands.

[4] NIMA's National Policy (NP) office has the responsibility of providing releasability guidance for all imagery, imagery intelligence, and geospatial information. The current trend is to develop and produce information at the lowest classification level possible. This effort will allow timely sharing of imagery-derived information for future operations.

[5] The Requirements Management System (within USIGS) is currently under development. When fully implemented, it will provide users a set of tools for prioritizing and submitting timely requirements for imagery and imagery intelligence.

[6] Softcopy workstations are the next generation of hardware and software tools that will facilitate imagery analysis production. The softcopy workstations are currently in development and testing within NIMA.

[7] This is NIMA's effort to increase the number of available imagery analysts that can be sent forward to provide on-site customer support (e.g. NIMA imagery analysts permanently assigned to JICs).

[8] The Exploitation Tools Initiative is an ongoing effort by NIMA and the community to develop/select commercial /government tools that can rapidly enhance imagery analysis capabilities.

[9] The Geospatial Information Integrated Product Team (GIIPT) was a DOD-wide IPT focused on changing the way geospatial information is produced and disseminated. The goal is to produce near global coverage of spatial imagery, terrain and feature data to support mission planning. Tailored datasets (that enhance existing information) will be produced in time to support specific missions such as NEOs.

[10] Collaborative Exploitation and Analysis is the focus of this paper. This process promotes the capability to collaboratively exploit, analyze, and produce imagery, imagery intelligence, and geospatial information. Through Collaborative Exploitation and Analysis, the JFC's staff, supporting JICs, other national agencies, and NIMA cooperate to produce the best information, in time, to support the mission.

[11] Image Product Library (IPL) is the current imagery server at several forward locations (e.g. USAF, 480th Intel Group). IPLs host various types of secondary image products.

[12] NIMA, United States Imagery and Geospatial Information System (USIGS) Technical Architecture, Draft, 17 August 1997, 60, Lkd: <http://www.nima.mil/aig/> (2 January 1998).

[13] Ibid., 61.

[14] Joint Chiefs of Staff (JCS), quoted in Office of Secretary of Defense, Director of Defense Research and Engineering (OSD/DDRE), Joint Warfighter Science and Technology Plan, January 1997, 1, Lkd. <http://www.dtic.mil:80/dstp/DSTP/97_jwstp/> (3 January 1998)

[15] Chairman of the Joint Chiefs of Staff, Joint Vision 2010, (Pentagon, Washington, DC: n.d.), 16.

[16] Joint Chiefs of Staff, Concept for Future Joint Operations, (Pentagon, Washington, DC: May 1997), 39.

[17] Ibid., 39.

[18] Stuart E. Johnson and Martin C. Libicki, ed., Dominant Battlespace Knowledge (Washington, DC: National Defense University, 1996), 99.

[19] OSD/DDRE, Joint Warfighter Science and Technology Plan, 2.

[20] Ibid., 2-3.

[21] US Naval War College, Commander's Estimate of the Situation: Worksheet for In-Class Work and War Gaming, (Newport, RI, September 1997), 2-1.

[22] OSD/DDRE, Joint Warfighter Science and Technology Plan, 3.

[23] Ibid., 4-7.

[24] NIMA, " Strategic Plan 1997," Lkd. <http://164.214.2.59/publications/StratPlan-web/index.htm/> (27 December 1997).

[25] NIMA, United States Imagery and Geospatial Information System (USIGS) Operational Architecture: The Operational Concept Diagram (OCD), Draft, June 1997, 6 Lkd: <http://www.nima.mil/aig/> (2 January 1998).

> Since October 1996, NIMA has been striving to move the imagery and geospatial communities closer together through its leadership of the United States Imagery and Geospatial Information System (USIGS). In this role, the agency is developing an end-to-end architecture to provide "direction and guidance to improve customer access to imagery, imagery intelligence, and geospatial information by facilitating the evolution of the Imagery and Geospatial Community from the current, predominantly hardcopy production, storage, and distribution environment to a predominantly digital, electronic analysis and information dissemination capability." Imagery and Geospatial Community (IGC) includes defense and civil users:
> **National Planning and Policymaking.** These organizations use imagery, imagery products, and geospatial information to plan and implement US national security policies. They include the National Command Authority and the National Security Council.
> **Military Operations.** These organizations include DoD peacetime organizations, and those engaged in combat, contingency, peacekeeping, and humanitarian operations conducted by the US, by

coalitions, and by allied nations. Examples include ground (2nd Mechanized Infantry Division), air (1st Fighter Wing), maritime (Nimitz Carrier Battle Group), and expeditionary units (I MEF).
Military Planning and Policymaking. Organizations in this category include military planning nodes such as the Joint Staff, Unified Command staffs, Joint Task Force (JTF) headquarters elements, and operations planning nodes of the component commands, such as United States Air Force, Central Command (CENTAF) and United States Army, Pacific (USARPAC). These organizations use imagery, imagery intelligence, and geospatial information in the conduct of contingency planning and decisionmaking.
Civil Planning and Policymaking. Planning and policymaking nodes exist in civil organizations such as Federal Emergency Management Agency (FEMA), the Department of the Interior, Drug Enforcement Administration (DEA), and state and local governments, where imagery, imagery products, and geospatial information are used to support the development of policies on land use, the environment, transportation.
Civil Operations. This category includes a variety of organizations engaged in humanitarian, crisis, and disaster response actions. Examples include FEMA disaster response teams, Department of Agriculture field teams, and US Forest Service firefighters.

[26] Geospatial Information Integrated Product Team (GIIPT), Geospatial Information Infrastructure (GII) Master Plan, Volume 3, Overview of the Technology Assessment, Version 1.0, 31 October 1997, 5.

[27] GIIPT, Geospatial Information Infrastructure Master Plan, Version 0.21, Volume 1 - Overview, 17 January 1997, 1.

[28] L. Scott Tillet, "NIMA to set map-making standard", Federal Computer Weekly, 15 December 1997, 18-20.

[29] GIIPT, GII Master Plan, Volume 3, Overview of the Technology Assessment, 15.

[30] Ibid., 15.

[31] John W. Strebeck, "Enhancing Battlespace Awareness by Centralizing National Imagery and Mapping Databases: A Force Multiplier," (Unpublished Research Paper, US Naval War College, Newport, RI: June 1997), 1.

[32] Based on author's participation and experience in JWID 95.

[33] Don Kusturin, "NIMA Says Anchors Aweigh with 3rd Fleet," The Edge, January 1998. Lkd. <http://osis.nima.mil/publications/edge01_98/edge01_98.html/> (13 January 1998).

[34] Defense Mapping Agency (DMA), Joint Warrior Interoperability Demonstration (JWID) 1996 Individual Demonstration Report, 29 August 1996, 2.

[35] Defense Information Systems Agency (DISA), D8, C4I Modeling, Simulation and Assessment, Joint Warrior Interoperability Demonstration (JWID) 1996 Report, 1 December 1996, Section 2, 15.

[36] GIIPT, GII Master Plan, Volume 3, Overview of the Technology Assessment, 15.

[37] Arthur F. Huber and others, The Virtual Combat Air Staff, The Promise of Information Technologies, (Santa Monica, CA: Rand, 1996), 3.

[38] MITRE Page for Collaborative Virtual Workspace Project, <http://www-i.mitre.org/pubs/showcase/cvw.html/> (8 January 1998).

[39] Author's personnel experience with NIMA, Systems and Technology efforts on collaborative computing.

[40] Jeffrey Richelson, The U.S. Intelligence Community 3rd ed. (Boulder: Westview Press 1995), 171.

[41] Ibid., 244.

[42] Huber and others, 44-45.

[43] Ibid, 58.

[44] NIMA, USIGS Technical Architecture, 62.

[45] Huber and others, 26.

[46] Office of Secretary of Defense, Director of Defense Research and Engineering (OSD/DDR&E), The 1997 Defense Technology Area Plan, 4-5, Lkd.< http://www.dtic.mil:80/dstp/DSTP/97_dtap/ > (3 January 1998).

[47] Dr. R. Tom Goodden, Information Superiority Integrated Product Team (IS IPT) Brief, Lkd. <http://www.dtic.mil:80/jcs/text/j6/edu_tr.html/> (06 January 1998).

BIBLIOGRAPHY

"Collaborative Virtual Workspace Project." Lkd. "MITRE Showcase Page" <http://www-i.mitre.org/pubs/showcase/cvw.html/> (8 January 1998).

Chairman of the Joint Chiefs of Staff. Joint Vision 2010. Pentagon, Washington, DC: n.d.

Defense Information Systems Agency (DISA), D8, C4I Modeling, Simulation and Assessment. Joint Warrior Interoperability Demonstration (JWID) 1996 Report. Arlington, VA: December 1996.

Defense Mapping Agency (DMA). Joint Warrior Interoperability Demonstration (JWID) 1996 Individual Demonstration Report. 29 August 1996.

Geospatial Information Integrated Product Team (GIIPT). Geospatial Information Infrastructure Master Plan, Version 0.21, Volume 1 - Overview. 17 January 1997.

_____. Geospatial Information Infrastructure (GII) Master Plan, Volume 3, Overview of the Technology Assessment, Version 1.0. 31 October 1997.

Goodden, Dr. R. Tom. "Information Superiority Integrated Product Team (IS IPT) Brief." Lkd. <http://www.dtic.mil:80/jcs/text/j6/edu_tr.html/> (06 January 1998).

Harris, C.J. and I. White, ed. Advances in Command, Control & Communications Systems. London: Peter Peregrinus Ltd., 1987.

Huber, Arthur F, Philip S. Sauer, J. Lawrence Hollett, Kenneth Keskel, William L. Shelton, Jr., and John T. Dillaplain. The Virtual Combat Air Staff, The Promise of Information Technologies. Santa Monica, CA: Rand, 1996.

Hura, Myron and Gary McLeod. Intelligence Support and Mission Planning for Autonomous Precision-Guided Weapons, Implications for Intelligence Support Plan Development. Santa Monica, CA: Rand, 1993.

Johnson, Stuart E. and Martin C. Libicki, ed. Dominant Battlespace Knowledge Washington, DC: National Defense University, 1996.

Joint Chiefs of Staff. Concept for Future Joint Operations. Pentagon, Washington, DC: May 1997.

Kusturin, Don. "NIMA Says Anchors Aweigh with 3rd Fleet." The Edge, January 1998. Lkd. <http://osis.nima.mil/publications/edge01_98/edge01_98.html/> (13 January 1998).

Libicki, Martin C. What is Information Warfare? Washington, DC: National Defense University, 1995.

NIMA. C4ISR Integrated Architecture Program (CIAP), Department of Defense Geospatial Information Architecture Volume I Main Report. Fairfax, VA: May 1997.

_____. Functional Manager's Guidance for the United States Imagery and Geospatial Information System (USIGS) Community FY 1999-2003. Fairfax, VA: n.d.

_____. " Strategic Plan 1997." Lkd. <http://164.214.2.59/publications/StratPlan-web/index.htm/> (27 December 1997).

_____. United States Imagery and Geospatial Information System (USIGS) Architectural Framework (UAF). 26 August 1997. Lkd: <http://www.nima.mil/aig> (2 January 1998).

_____. United States Imagery and Geospatial Information System (USIGS) Operational Architecture: The Operational Concept Diagram (OCD) Draft. June 1997. Lkd: <http://www.nima.mil/aig/> (2 January 1998).

_____. United States Imagery and Geospatial Information System (USIGS) Technical Architecture, Draft. 17 August 1997. Lkd. <http://www.nima.mil/aig/> (2 January 1998).

Office of Secretary of Defense, Director of Defense Research and Engineering (OSD/DDR&E), The 1997 Defense Technology Area Plan. 4-5, Lkd. <http://www.dtic.mil:80/dstp/DSTP/97_dtap/> (3 January 1998).

Richelson, Jeffrey. The U.S. Intelligence Community. 3rd ed. Boulder: Westview Press, 1995.

Strebeck, John W. "Enhancing Battlespace Awareness by Centralizing National Imagery and Mapping Databases: A Force Multiplier." Unpublished Research Paper, US Naval War College, Newport, RI: 1997.

Tillet, L. Scott. "NIMA to set map-making standard." Federal Computer Weekly. 15 December, 1997. 18-20.

US Naval War College. Commander's Estimate of the Situation: Worksheet for In-Class Work and War Gaming. Newport, RI: September 1997.